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Faces as perceptual wholes: The interplay between component and configural properties in face processing

Ruth Kimchi and Rama Amishav
University of Haifa, Haifa, Israel

The relative dominance of component and configural properties in face processing is a controversial issue. We examined this issue by testing whether the discriminability of components predicts the discrimination of faces with similar versus dissimilar configurations. Discrimination of faces with similar configurations was determined by components discriminability, indicating independent processing of facial components. The presence of configural variation had no effect on discriminating faces with highly discriminable components, suggesting that discrimination was based on the components. The presence of configural variation, however, facilitated the discrimination of faces with more difficult-to-discriminate components, above and beyond what would be predicted by the configural or componential discriminability, indicating interactive processing. No effect of configural variation was observed in discriminating inverted faces. These results suggest that both component and configural properties contribute to the processing of upright faces and no property necessarily dominates the other. Upright face discrimination can rely on components, configural properties, or interactive processing of component and configural properties, depending on the information available and the discriminability of the properties. Inverted faces are dominated by componential processing. The finding that interactive processing of component and configural properties surfaced when the properties were of similar, not very high discriminability, suggests that such interactive processing may be the dominant form of face processing in everyday life.

Keywords: Configural and holistic processing; Configural properties; Face processing; Facial components; Interactive processing of component and configural properties.

Please address all correspondence to Ruth Kimchi, Department of Psychology, University of Haifa, Haifa 31905, Israel. E-mail: rkimchi@research.haifa.ac.il

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Humans' ability to perceive and recognize faces is remarkable. We discriminate and recognize a large number of faces, and in most cases we do it readily and accurately. It has been widely believed that configural, or holistic, processing underlies this ability (e.g., Diamond & Carey, 1986; Farah, Wilson, Drain, & Tanaka, 1998; Gauthier & Tarr, 2002; Leder & Bruce, 2000; Maurer, Le Grand, & Mondloch, 2002; McKone, 2008; Peterson & Rhodes, 2003; Tanaka & Farah, 1993). The finding that inversion impairs the recognition of faces much more than the recognition of other objects (Yin, 1969) is traditionally attributed to disruption of configural/holistic processing with inversion.

Configural/holistic processing is commonly contrasted with analytic or part-based processing, in which faces are identified, discriminated, or recognized on the basis of its elementary parts (e.g., eyes, nose, or mouth). The exact nature of configural/holistic processing, however, is not yet well understood, and although the terms "configural" and "holistic" are sometimes used interchangeably, they often refer to different kinds of processing. The most prominent views of holistic/configural processing are the holistic view and the configural view.

The holistic view posits that faces are perceived and represented as unified perceptual wholes (e.g., Farah, Tanaka, & Drain, 1995; Farah et al., 1998; Tanaka & Farah, 1993; Tanaka & Sengco, 1997; Young, Hellawell, & Hay, 1987). In its extreme version, this view assumes that faces are not decomposed into parts, so that facial components are not explicitly represented and play no role in face processing (Farah et al., 1998; Tanaka & Farah, 1993). Several empirical findings, in particular, the part–whole effect and the composite face effect, have been interpreted as supporting the holistic hypothesis. The part–whole effect (Tanaka & Farah, 1993, 2003) refers to the finding that a particular face part is recognized more accurately when tested in the whole studied face than when tested in isolation (but see, Homa, Haver, & Schwartz, 1976). In the composite face effect (Young et al., 1987), aligning two half faces of different individuals makes it difficult to recognize the person in the top half compared with a condition in which the two halves are misaligned. Both effects are absent for inverted faces (e.g., Carey & Diamond, 1994; Goffaux & Rossion, 2006; Hole, 1994; Robbins & McKone, 2007; Tanaka & Farah, 1993; Tanaka, Kay, Grinnell, Stansfield, & Szechter, 1998; Young et al., 1987), and are much weaker or absent for nonface objects (e.g., Donnelly & Davidoff, 1999; Gauthier & Tarr, 1997, 2002; Robbins & McKone, 2007; Tanaka & Farah, 1993; Tanaka et al., 1998).

The holistic hypothesis, however, has not been unchallenged. For example, it was claimed that the part–whole effect can be ascribed to alternative mechanisms, such as processing of the spatial relations between components, which is disrupted when facial components are removed (Williams, Moss, &

Bradshaw, 2004). Also, several findings suggest that components are explicitly represented in upright faces (e.g., Anaki & Moscovitch, 2007; Schwaninger, Lobmaier, & Collishaw, 2002), thus challenging the assumption that face representation is unparsed. Recently, Konar, Bennett, and Sekuler (2010) found no correlation between the magnitude of face composite effect and face identification accuracy, questioning the assumption that face recognition is driven by holistic processing.

The configural view posits that spatial relations between facial components (i.e., spacing of the eyes, nose, and mouth relative to each other), rather than components, play a crucial role in face processing (e.g., Cooper & Wojan, 2000; Diamond & Carey, 1986; Leder & Bruce, 1998, 2000; Rhodes, 1988; Rhodes, Brake, & Atkinson, 1993; Searcy & Bartlett, 1996). These "second-order spatial relations", often referred to as configural information (e.g., Ingvalson & Wenger, 2005; Leder & Bruce, 2000; Schwaninger, Carbon, & Leder, 2003), are assumed to be critical for the processing of individual faces. They are distinguished from "first-order spatial relations", which refer to the basic arrangement of the components (i.e., the eyes above the nose and the mouth below the nose) and are critical for discriminating faces from other object classes (Diamond & Carey, 1986; Maurer et al., 2002). Several studies have demonstrated that even minute changes to the spacing between components can be perceived when faces are upright (Haig, 1984; Hosie, Ellis, & Haig, 1988; Kemp, McManus, & Pigott, 1990). The main support for the configural view comes from studies demonstrating that inversion disrupts the processing of configural information, whereas the processing of components is relatively immune to inversion (e.g., Freire, Lee, & Symons, 2000; Leder & Bruce, 1998, 2000; Leder, Candrian, Huber, & Bruce, 2001; Le Grand, Mondloch, Maurer, & Brent, 2001; Mondloch, Le Grand, & Maurer, 2002; Murray et al., 2000).

The configural view, however, has been challenged by recent findings showing that the processing of configural and componential information can be equally affected by face inversion (Riesenhuber, Jarudi, Gilad, & Sinha, 2004; Yovel & Kanwisher, 2004), and finding suggesting that the inversion effect reflects reduced efficiency rather than a qualitative change in face processing (Sekuler, Gaspar, Gold, & Bennett, 2004).

Although the exact definition of the terms holistic or configural processing remains a matter of an ongoing debate (e.g., Maurer et al., 2002; Peterson & Rhodes, 2003), there is a great deal of evidence that face components also play an important role in face processing (e.g., Bruyer & Coget, 1987; Cabeza & Kato, 2000; Collishaw & Hole, 2000; Harris & Nakayama, 2008; Martelli, Majaj, & Pelli, 2005; Rakover & Teucher, 1997; Rotshtein, Geng, Driver, & Dolan, 2007; Schwarzer & Massaro, 2001; Tversky & Krantz, 1969; Valentin, Abdi, & Edelman, 1999). For example, Rakover and Teucher (1997) estimated that 91% of the variation in the recognition of an upright face is accounted for by its isolated components, and Rotshtein et al. (2007) found that face discrimination was dominated by facial components. One attempt to consider the roles of both component and configural information is the dual-mode hypothesis (e.g., Bartlett & Searcy, 1993; Searcy & Bartlett, 1996). According to this hypothesis, face processing is supported by two distinct sources of information—configural and componential—that are processed independently, with configural information dominating upright face processing. Some studies provided evidence for independent processing of configural and component information (Cabeza & Kato, 2000; Collishaw & Hole, 2000), whereas other findings suggest interactive processing (Ingvalson & Wenger, 2005; Sergent, 1984; Tanaka & Sengco, 1997).

As can be seen from this short review, although configural/holistic processing is considered a hallmark of face processing, there is much debate about exactly what this processing is. The evidence for each of the prominent views has been contested, and there exist empirical findings that challenge the claims of each view. Furthermore, there is growing converging evidence suggesting that both componential and configural information is involved in face processing (e.g., Schwaninger, et al., 2003). Yet, the relative contribution of componential and configural information, and the interplay between them, remain controversial issues. Understanding these issues appears to be constrained partly by the paucity of methodologies to assess component and configural processing. This is evident in the widespread use of the inversion effect as a marker for configural processing despite the debate over its nature—whether it involves qualitative or quantitative changes in face perception (e.g., Sekuler et al., 2004; Valentine, 1988; see Rossion, 2008, for a review) and whether or not it is unique to faces (e.g., Ashworth, Vuong, Rossion, & Tarr, 2008).

This study attempted to examine the relative contribution of and the relationship between component and configural information in face processing, using a strategy that is not commonly used in the context of face perception. The approach we have taken is derived from the notion that a face is a multidimensional visual object that has both component and configural properties, and the critical question is whether configural properties dominate component properties in object identification, discrimination, or classification (Garner, 1978, 1981; Kimchi, 1992, 1994, 2003). Configural properties are the consequence of the interrelations between components. These properties do not inhere in the components, nor can they be predicted by considering only the individual components; it is these configural properties that make the whole different from the sum of its parts (e.g., Garner, 1978, 1981; Kimchi, 1992, 1994; Pomerantz, 1981; Pomerantz & Pristach, 1989; Rock, 1986). In the visual domain, the interrelations between components often refer to spatial relations—in many cases the mere displacement of a component suffices to change the configural properties, whereas replacing the components does not change the configuration (e.g., displacement of one of three dots forming a triangle can create a straight line, but replacing the dots with stars preserves the triangular configuration). However, components may also interact, so that changing the components alone while keeping their spatial arrangement intact can result in new configural properties: for example, the configuration of right- and left-curving lines "()", which has closure, changes when the line on the left is replaced by ")", resulting in a configuration that has parallelism "))" (see Pomerantz, 1981).

Accordingly, we use *components* to refer to the elementary parts of a face (e.g., eyes, nose, mouth), and *configural properties* to refer to properties that are a consequence of interrelations between the facial components, spatial or other. There is some evidence, however, that facial components do not interact with one another. For example, Sergent (1984), using speeded matching and dissimilarity judgement tasks, found that eyes and chin were processed independently, and Schwarzer and Massaro (2001) reported independent processing of eyes and mouth in face identification (see also Pomerantz et al., 2003). Thus, we assume that configural properties of faces are mainly a consequence of spatial relations between components. These spatial relations include the basic spatial arrangement of face components, which gives rise to the configural property of "faceness", and spatial relations between components, such as the spacing of components relative to the basic spatial arrangement. Note that, although our notion of configural properties is related to the notion of first- and second-order spatial relations, it is not identical to it. That is, in our view configural properties are not equated with spatial relations between components (or with any other possible relations between components), rather, they are a consequence of these relations. For example, vertical spacing in a face—longer versus shorter—can give rise to configural properties of "elongation" versus "roundness", respectively.

We addressed the issue of the relative dominance of component and configural properties in face processing by examining whether the discriminability of isolated facial components predicts the discriminability of whole faces composed of these components. We reasoned that if the individual components are the only contributor to performance, then the discrimination of the faces should be determined by the discriminability of the components. If, however, configural properties dominate component properties in the discrimination of faces, then the discrimination of faces with dissimilar configural properties should always be easier than the discrimination of faces with similar configural properties, *regardless* of the discriminability of the components.

Following this logic, we first obtained the discriminability of facial components (eyes, noses, and mouth) presented in isolation, using forced-choice discrimination tasks (Experiment 1). We then embedded these components in whole faces, so that faces differed only in a single component, and obtained performance in discrimination tasks with the faces (Experiment 2). By comparing the pattern of performance across Experiments 1 and 2 we could determine whether the discrimination of the faces is determined by the discriminability of their components. This also enabled us to determine whether facial components interact with one another to produce configural properties. The critical experiment was Experiment 3, in which the most discriminable and the least discriminable components—based on the results of Experiment 1—were embedded in whole faces, such that faces differed only in components (i.e., had similar configural properties) or in both components and spatial relations between the components (i.e., had dissimilar configural properties). Examining the effect of component discriminability on discrimination performance of faces with similar configural properties versus faces with dissimilar configural properties allowed us to assess the relative dominance of components and configural properties.

EXPERIMENT 1

Experiment 1 was designed to obtain the relative discriminability of facial components. To this end, participants performed discrimination tasks with a set of four exemplars of a facial component (e.g., eyes) presented in isolation, for three types of components—eyes, nose, and mouth. The discrimination performance reveals the degree of perceived interstimulus similarity between each exemplar and each of the others in the set. If two stimuli are perceived as very similar, then discriminating between them will be very difficult. Thus, the discrimination performance would yield, for each component type, the relative discriminability of pairs of exemplars, from the least discriminable pair to the most discriminable pair.

Method

Participants. Forty-eight undergraduates from the University of Haifa were randomly assigned to three conditions: 16 participants (3 females, 13 males; age range: 18–30 years) discriminated between pairs of eyes, 16 participants (10 females, 6 males; age range 20–36 years) discriminated between pairs of noses, and 16 participants (12 females, 4 males; age range 19–43 years) discriminated between pairs of mouths. All had normal or corrected-to-normal vision, and were paid for their participation (30 NIS).

Stimuli and apparatus. Stimuli were created using a computerized facial composite software (FACES 3.0, 1998). We randomly selected from the software's database four exemplars of each type of facial component to create three sets of four exemplars each, with the constraint that the stimuli within set were similar in size (Figure 1): The Eyes set (E1, E2, E3, E4), the Nose set (N1, N2, N3, N4), and the Mouth set (M1, M2, M3, M4). Stimuli sizes were approximately 1.5 cm × 6 cm for the eyes, 2.5 cm × 3 cm for the noses, and 1.5 cm × 3 cm for the mouth. Images were black and white and appeared on a grey background. The Experiment was controlled by a PC computer, with an Intel 4-Pentium processor (1.6 GHz).

Design and procedure. For each stimulus set (Eyes, Nose, or Mouth) there were six discrimination tasks, according to the six possible different pairing of the four stimuli in the set. Thus, each discrimination task involved a subset of two stimuli. Participants were presented with the stimuli, one stimulus at a time, and were required to make a speeded response to each stimulus by pressing one of two response keys. Each task was presented in a separate block of 52 experimental trials, preceded by 12 practice trials, with each stimulus occurring on an equal number of trials. Participants were informed about the relevant stimuli and the response assignment to each stimulus at the beginning of each task, and were requested to respond as quickly and as accurately as possible. Task order and stimulus order of presentation within task were randomized for each participant.

Participants were seated 60 cm from the screen, with their heads resting on a chinrest in a dimly lit room. Each experimental trial begun with the appearance of a fixation dot for 500 ms. After a 500 ms interval, the stimulus appeared at the centre of the screen and stayed on until response (for a maximum of 3500 ms). In case of an incorrect response an auditory tone was presented and the trial was retaken (up to three times) at the end of the block.

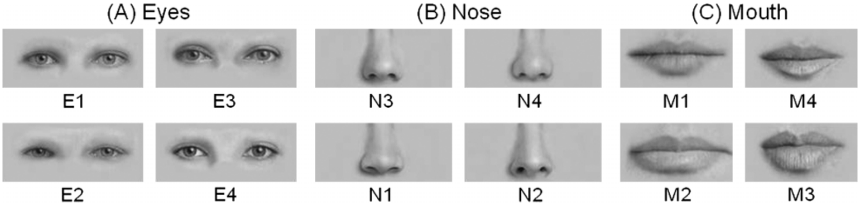

Figure 1. The three stimulus sets used in Experiment 1: (A) a set of four eyes, (B) a set of four noses, and (C) a set of four mouths. The top pair in each set is the least discriminable pair and the bottom pair in each set is the most discriminable pair.

Results and discussion

All response time (RT) summaries and analyses in all experiments are based on participants mean RTs for correct responses. RTs lower than 250 ms or greater than 2500 ms were omitted from the analyses (0%, 0.3%, and 0.13% of all trials, for Experiments 1, 2, and 3, respectively).

Mean RTs and error rates (ERs) for the six discrimination tasks for each stimulus set are presented in Table 1. Overall discrimination accuracy was high (mean ER = 2.7%), and there was no indication of speed–accuracy tradeoffs. Therefore, errors are not discussed further.

The RT data were submitted to a 3 (component type) × 6 (task) analysis of variance (ANOVA), which treated component as a between-subjects factor and task as a within-subjects factor nested within component. The analysis showed a significant effect of component, $F(2, 225) = 44.15$, $p < .0001$, $\eta_p^2 = .34$. Tukey HSD comparisons ($\alpha = .05$) indicated that overall discrimination for the mouth (mean = 683 ms) were significantly faster than responses for the eyes (mean = 734 ms), which in turn were significantly faster than responses for the nose (mean = 758 ms). Discrimination RT varied with task for all three component types: Eyes, $F(5, 75) = 8.86$, $p < .0001$, $\eta_p^2 = .31$; nose, $F(5, 75) = 8.15$, $p < .0001$, $\eta_p^2 = .35$; mouth, $F(5, 75) = 4.72$, $p < .0008$, $\eta_p^2 = .24$. Tukey HSD comparisons were used to assess the differences between the tasks for each component set. As can be seen in Table 1, for the eyes set, the slowest discrimination was for pairs E1–E3 and E1–E2, which was significantly slower than the discrimination for the fastest pairs E2–E3 and E2–E4; for the nose set, pair N3–N4 yielded the slowest discrimination, which was significantly slower than the discrimination for the fastest pairs N1–N3 and N1–N2; for the mouth set, the slowest discrimination was for pair M1–M4, which was significantly slower than the discrimination for the fastest pair M2–M3.

TABLE 1
Mean RT (in ms) and ER (%) for the six discrimination tasks for each component type (eyes, nose, mouth), presented in order of latency, in Experiment 1

Eyes			*Nose*			*Mouth*		
Task	*RT*	*ER*	*Task*	*RT*	*ER*	*Task*	*RT*	*ER*
E1–E3	799	3.9	N3–N4	827	6.7	M1–M4	721	2.8
E1–E2	759	2.4	N2–N3	798	3.6	M2–M4	702	2.2
E3–E4	740	3.2	N1–N4	749	3.9	M3–M4	685	2.5
E1–E4	738	2.4	N2–N4	736	1.6	M1–M2	680	1.3
E2–E3	689	1.5	N1–N3	721	2.6	M1–M3	658	1.8
E2–E4	681	1.6	N1–N2	719	1.9	M2–M3	652	1.5

The results of Experiment 1 provided the relative discriminability of pairs of components in each set (eyes, nose, and mouth), thus yielding the most discriminable and the least discriminable pairs of components for each component type. The results further indicated that for the components employed in this experiment, the discrimination of mouth was the easiest and the discrimination of nose was the most difficult one, particularly for the least discriminable pairs.

EXPERIMENT 2

In this experiment the components used in Experiment 1 were embedded within whole faces to create three sets of four faces each: A set of faces that varied only in the eyes (F-eyes), a set of faces that varied only in the nose (F-nose), and a set of faces that varied only in the mouth (F-mouth). Discrimination tasks were performed with each set of faces to yield the relative discriminability of pairs of faces, from the least discriminable pair to the most discriminable pair. A comparison between the *pattern* of performance in Experiments 1 and 2 will reveal whether the discriminability of the isolated components predicted the discrimination of whole faces differing in these components. If the individual components are the only contributor to performance, then the components should contribute to the relative speed of performance in the same way as when the components were presented in isolation.

Several researchers (e.g., Schwaninger et al., 2003; Tanaka & Farah, 2003) argued that altering components may influence the spatial relations between components (e.g., altering the nose can change the distance between the nose and the mouth). Notwithstanding this argument, it should be possible, in principle, to manipulate the components without affecting the spatial relations (see Maurer et al., 2002; Mondloch et al., 2002), although it may be difficult to do so. Accordingly, we made great effort to avoid this potential confounding as much as possible (see later).

Method

Participants. Forty-eight new individuals were randomly assigned to three conditions. Sixteen participants (14 females, 2 males; age range: 18–27 years) discriminated between faces differing only in the eyes, 16 (11 females, 5 males; age range: 18–26 years) discriminated between faces differing only in the nose, and 16 (9 females, 7 males; age range: 22–27 years) discriminated between faces differing only in the mouth. All had normal or corrected-to-normal vision, and were paid 30 NIS for their participation.

Stimuli and apparatus. The isolated components of Experiment 1 were embedded within whole faces to create three sets of four faces each (Figure 2): F-eyes—a set of four faces that varied only in the eyes (FE1, FE2, FE3, FE4); F-nose—a set of four faces that varied only in the nose (FN1, FN2, FN3, FN4); and F-mouth—a set of four faces that varied only in the mouth (FM1, FM2, FM3, FM4). To minimize as much as possible the possibility that altering components would result in changes in the spatial distances between the components, the chosen components were similar in their sizes, and were carefully pasted in the exact locations of the face using graphics software program (Adobe Photoshop, version 8; for similar procedure see Mondloch et al., 2002). Faces were 10×15 cm in size. In all other respects stimulus generation and apparatus were identical to those of Experiment 1.

Design and procedure. The design and procedure were identical to those of Experiment 1.

Results and discussion

Mean RT and ER for the six discrimination tasks for each stimulus set (F-eyes, F-nose, F-mouth) are presented in Table 2. Overall discrimination accuracy was high (mean ER = 3%), and there was no indication of speed–accuracy tradeoffs. Therefore, errors are not discussed further.

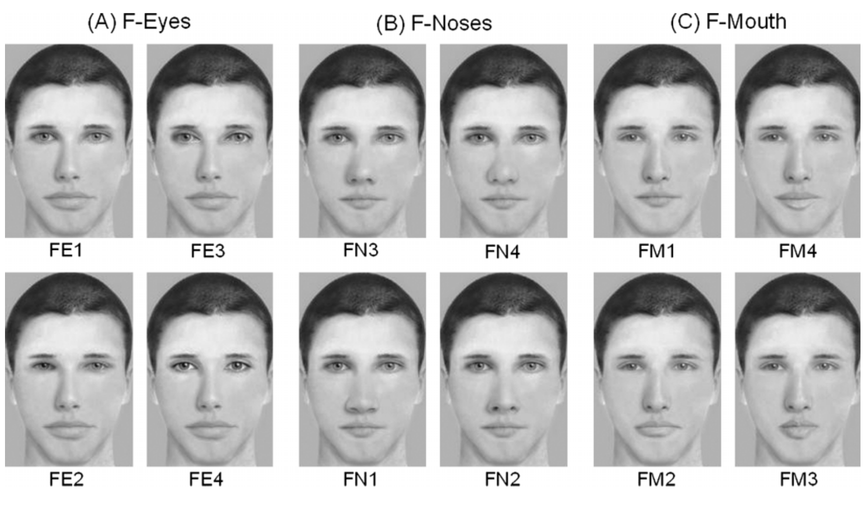

Figure 2. The three stimulus sets used in Experiment 2: (A) a set of four faces differing in eyes, (B) a set of four faces differing in nose, and (C) a set of four faces differing in mouth. The top pair in each set is the least discriminable pair and the bottom pair in each set is the most discriminable pair.

TABLE 2
Mean RT (ms) and ER (%) for the six discrimination tasks for faces differing only in eyes (F-eyes), noses (F-noses), or mouth (F-mouth), presented in order of latency, in Experiment 2

F-eyes			*F-nose*			*F-mouth*		
Task	*RT*	*ER*	*Task*	*RT*	*ER*	*Task*	*RT*	*ER*
FE1–FE3	808	6.9	FN3–FN4	877	3.8	FM2–FM4	741	3.1
FE3–FE4	788	4.5	FN2–FN4	838	3.3	FM1–FM4	739	1.2
FE1–FE2	743	2.9	FN2–FN3	830	2.2	FM1–FM3	732	1.8
FE1–FE4	740	3.0	FN1–FN4	826	3.1	FM3–FM4	722	1.0
FE2–FE3	716	2.1	FN1–FN3	812	2.2	FM1–FM2	716	2.1
FE2–FE4	706	2.6	FN1–FN2	788	2.7	FM2–FM3	681	0.8

The pattern of results obtained in Experiment 2 (Table 2) was similar to the one obtained in Experiment 1 (Table 1): The relative difficulty of the discrimination of the faces, both between and within component type, was similar to that of their components in isolation. These observations were confirmed by a 3 (component type) $\times$ 6 (task) ANOVA, with component type as a between-subjects factor and task as a within-subjects factor nested within component, which was conducted on the RT data. The analysis showed a significant effect of component type, $F(2, 225) = 63.57$, $p < .0001$, $\eta_p^2 = .36$. Tukey HSD comparisons showed that, similarly to the results observed for the isolated components, discrimination of faces differing in mouth (mean = 722 ms) was significantly faster than discrimination of faces differing in eyes (mean = 750 ms), which in turn were significantly faster than discrimination of faces differing in nose (mean = 828 ms). Discrimination latency varied with task for all three sets: F-eyes, $F(5, 75) = 4.09$, $p < .003$, $\eta_p^2 = .21$; F-nose, $F(5, 75) = 2.74$, $p < .03$, $\eta_p^2 = .15$; F-mouth, $F(5, 75) = 3.2$, $p < .02$, $\eta_p^2 = .18$. Tukey HSD comparisons assessed the differences between the tasks for each set. For the F-eyes set, pair FE1–FE3 that differed in the least discriminable eyes, yielded the slowest discrimination, which was significantly slower than discrimination for the fastest pair FE2–FE4 that differed in the most discriminable eyes; for the F-nose set, the slowest discrimination was obtained for pair FN3–FN4 that differed in the least discriminable noses, which was significantly slower than discrimination for the fastest pair FN1–FN2 that differed in the most discriminable noses; for the F-mouth set, the slowest discrimination was obtained for pairs FM2–FM4 and FM1–FM4 that differed in the least discriminable mouths, which was significantly slower than discrimination for the fastest pair FM2–FM3 that differed in the most discriminable mouths.

These results show that, for each component type, the relative difficulty of the discrimination tasks for the faces was similar to that of their respective components in isolation. In particular, the most discriminable pair of faces was the one that differed in the pair of components that was the most discriminable when presented in isolation. Likewise, the least discriminable pair of faces was the one that differed in the pair of components that was the least discriminable when presented in isolation. To compare the discrimination latency for the pairs of faces versus the pairs of the isolated components, we conducted a 2 (experiment) × 3 (component) × 2 (pair) ANOVA, with experiment (Experiment 1, Experiment 2) and component (eyes, nose, mouth) as between-subjects factors and pair (most discriminable, least discriminable) as a within-subjects factor nested within component. As expected, the analysis showed significant effects of component, $F(2, 90) = 32.78$, $p < .0001$, $\eta_p^2 = .42$, and pair, $F(3, 90) = 25.99$, $p < .0001$, $\eta_p^2 = .46$. There was no significant difference in discrimination latency between experiments, $F(1, 90) = 2.33$, $p > .13$, and no significant interactions between experiment and component, $F(2, 90) = 1.54$, $p > .21$, or between experiment and pair, $F < 1$.

Thus, not only the relative difficulty of the discrimination of the faces was similar to that of their components in isolation, but the discrimination latency did not differ significantly. These results are congruent with pervious findings demonstrating no advantage for detecting a face part in the context of a face than without the face context (Homa et al., 1976; Mermelstein, Banks, & Prinzmetal, 1979).

Taken together, the results of Experiments 1 and 2 indicate that the discrimination of upright faces that differed in only one component (i.e., eyes, nose, or mouth), and that were otherwise similar to each other, was determined by the discriminability of the component. This finding may not be surprising—after all the faces differed only in a single component. Presumably, participants rapidly realized that the differing component is diagnostic for the discrimination task. This may be particularly true considering that only two faces were involved in each task. Nonetheless, this finding has important implications—it implies that facial components are explicitly represented in upright faces and do not interact with one another. This finding is congruent with previous findings suggesting that facial components are processed independently (e.g., Macho & Leder, 1998; Schwarzer & Massaro, 2001; Sergent, 1984).

Thus, in the absence (or near absence) of variation in spatial relations between components, faces appear to be the sum of their components, so that each components combination is predicted from its components. This finding supports our assumption that configural properties in faces arise mainly from the spatial relations between facial components, rather than from interaction between facial components as such.

Real faces obviously vary in multiple components and configural properties. What is the relation between component and configural properties? Do configural properties override the diagnosticity of the components? These questions are addressed in the next experiment.

EXPERIMENT 3

The main purpose of this experiment was to examine the relative dominance of component and configural properties in face processing, by testing the effect of the discriminability of the components on the discrimination of the faces with similar configural properties versus faces with dissimilar configural properties.

Based on the data obtained in Experiment 1, the most discriminable and the least discriminable pairs of components of each type (eyes, nose, or mouth) were embedded in whole faces. Participants discriminated between pair of faces, both upright and inverted, in two configural similarity conditions. In the *similar configuration* (SC) condition the faces varied only in components, with no configural variation, so that one pair of faces differed in the least discriminable components (Figure 3, pair A) and the other pair of faces differed in the most discriminable components (Figure 3, pair B). In the *dissimilar configuration* (DC) condition, configural variation, manipulated by altering the intereyes distance and the nose–mouth distance, was added to each of the faces in these two pairs, so that one pair of faces differed in the least discriminable components *and* in intereye and nose–mouth distances (Figure 3, pair C), and the other pair of faces differed in the most discriminable properties *and* in the same intereye and nose–mouth distances as pair C (Figure 3, pair D). The spatial manipulation introduced in the DC condition was based on discrimination performance in a preliminary experiment to ensure that the discriminability of each spatial difference is within the range of the discriminability of the components (in both RT and accuracy), and that the spatial change does not make the face look grotesque.[1]

If in the absence of configural variation upright faces are the sum of their components, as suggested by the results of Experiments 1 and 2, then the

[1] In this preliminary experiment we used two sets of four faces each: The faces in the intereyes set varied *only* in intereyes distance, and the faces in nose–mouth set varied *only* in nose–mouth distance. The four faces in each condition were created by modifying a single face in a way similar to the one described by Mondloch et al. (2002). Sixteen participants performed six discrimination tasks with the intereyes set, and another 16 participants performed six discrimination tasks with the nose–mouth set. Based on the discrimination data we chose intereye distances and nose–mouth distances that yielded discrimination latency and accuracy (756 ms, 3.8%, and 850 ms, 3.0%, for intereyes distance and nose–mouth distance, respectively) that were within the range of the discrimination latency and accuracy of the components, while not making the faces look grotesque.

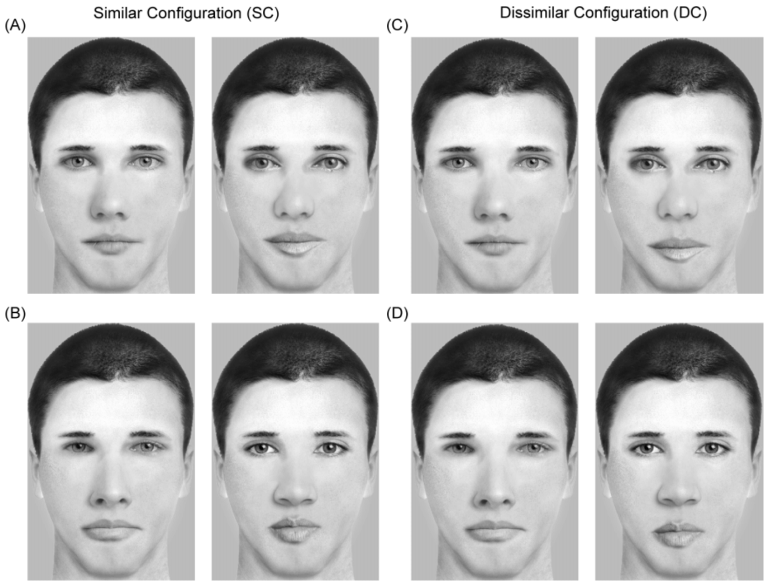

Figure 3. The stimuli used in Experiment 3. The faces in the similar configuration (SC) condition (pairs A and B) differ in eyes, nose, and mouth, with no configural variation. The faces in the dissimilar configuration (DC) condition (pairs C and D) differ in the same components as pairs A and B *and* in intereyes distance and nose–mouth distance. The configural variation is the same for pairs C and D. Pairs A and C vary in the least discriminable components, and pairs B and D vary in the most discriminable components.

discrimination of faces that differ only in their components (SC condition) should be determined by the discriminability of the components. Thus, the discrimination for faces differing in the most discriminable components is expected to be faster than discrimination for faces differing in the least discriminable components. If configural properties, however, dominate component properties in the discrimination of upright faces, then discrimination between faces that differ in configural properties (DC condition) should be faster than discrimination between faces that have similar configural properties (SC condition), *regardless* of the discriminability of the components. In addition, since the configural variation was the same for the two pairs in the DC condition, the difference between these two pairs due to differences in component discriminability is expected to diminish.

If inversion disrupts the extraction of spatial relations between components, as several researchers have suggested (e.g., Freire et al., 2000; Leder & Bruce, 2000; Leder et al., 2001; Searcy & Bartlett, 1996), then inverted faces should be discriminated by the components and configural variation should have no effect on the discrimination performance.

Method

Participants. Thirty-two new individuals were randomly assigned to the two conditions: 16 (8 females, 8 males; age range: 21–30 years) participated in the similar configuration (SC) condition, and 16 (8 females, 8 males; age range: 19–25 years) participated in the dissimilar configuration (DC) condition. All reported normal or corrected-to-normal vision, and were paid for their participation (30 NIS).

Stimuli and apparatus. Stimuli preparation and apparatus were similar to those of Experiments 1 and 2. Figure 3 depicts the stimuli used in this experiment. The sizes of the faces were identical to those of Experiment 2. The two pairs of faces in the SC condition (pairs A and B) differed in all three components—eyes, nose, and mouth, but the spatial relations between the components were kept constant. The two pairs of faces in the DC condition (pairs C and D) differed in all three components *and* in the spatial relations between the components. The faces in pairs A and C differed in the components that were least discriminable in Experiment 1 (eyes: E1–E3, nose: N3–N4, mouth: M1–M4; see Figure 1, Table 1); the faces in pairs B and D differed in components that were most discriminable in Experiment 1 (eyes: E2–E4, nose: N1–N2, mouth: M2–M3; see Figure 1, Table 1). As in Experiment 2, great care was taken to ensure, as much as possible, that replacing components had no effect on spatial relations between components.

The spatial relations in pairs C and D were manipulated by altering the intereyes and nose–mouth distance, using Adobe Photoshop software (version 8). Intereyes distance was defined as the distance between the centres of the pupils, and the nose–mouth distance was defined as the distance between the lower edge of the nose and the edge of the upper lip. The two intereyes distances were 42 mm (the left faces of pairs C and D) and 38 mm (the right faces of pairs C and D), yielding a difference of 4 mm in intereye distance. The two nose–mouth distances were 10 mm (the left faces of pairs C and D) and 13 mm (the right faces in pairs C and D), so that the difference in nose–mouth distance was 3 mm. Thus, the faces in pairs C differed in the least discriminable components and faces in pair D differed in the most discriminable components, whereas pairs C and D had similar spatial variation.

Design and procedure. The experiment employed the factorial combination of three factors: Configural similarity (similar configuration—SC, dissimilar configuration—DC), component discriminability (most discriminable, least discriminable), and orientation (upright, inverted). Configural similarity was administered between subjects, and discriminability and orientation were administered within subjects. Each participant performed two discrimination tasks of 52 trials each (the discrimination task was the same as the one used in the previous experiments; for description see Experiment 1's method). Participants in the SC condition performed one discrimination task involving the faces of pair A, and another task involving the faces of pair B. Participants in the DC condition performed one discrimination task involving the faces of pair C, and another task involving the faces of pair D. Participants performed the two tasks in each orientation. Order of orientation and task were counterbalanced across participants and order of trials was randomized for each participant. All other aspects of the procedure were identical to those of the former experiments.

Results and discussion

Mean RTs as a function of configural similarity and component discriminability for upright and inverted faces are depicted in Figure 4; ERs are presented in Table 3. Accuracy was at ceiling (mean ER = 1.33%), and there

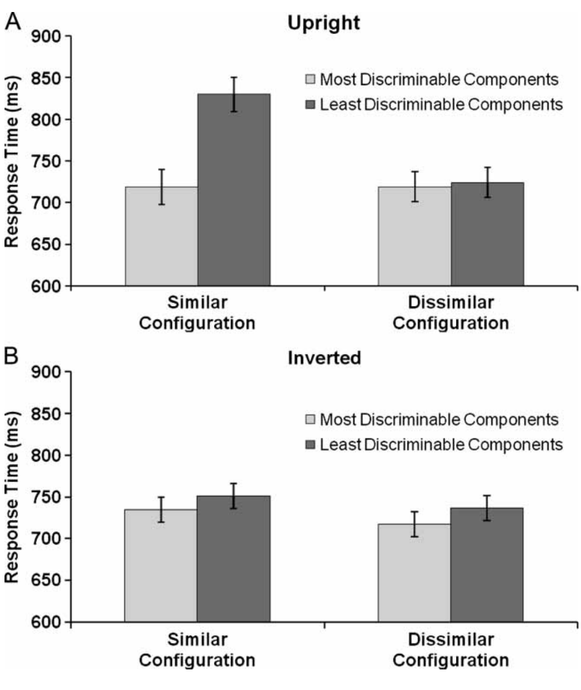

Figure 4. Results for Experiment 3. Mean response times for (A) upright faces and (B) inverted faces, as a function of configural similarity and component discriminability. Error bars indicate standard error of the mean.

TABLE 3
Error rate (%) for upright an inverted faces differing in the most- and least-discriminable components in the SC and DC conditions in Experiment 3

	Upright		*Inverted*	
	SC	*DC*	*SC*	*DC*
Most discriminable	0.8	0.7	1.6	1.1
Least discriminable	2.3	0.7	2.2	1.2

was no indication of speed–accuracy tradeoffs. Therefore, errors are not discussed further.

The RT data were submitted to a 2 (configural similarity) × 2 (discriminability) × 2 (orientation) ANOVA, with configural similarity as a between-subjects factor, and component discriminability and orientation as within-subjects factors. The analysis showed a main effect of discriminability, $F(1,\ 30) = 9.3$, $p < .005$, $\eta^2_p = .24$, a significant interaction between configural similarity and discriminability, $F(1,\ 30) = 4.27$, $p < .05$, $\eta^2_p = .12$, and a significant interaction between configural similarity, discriminability, and orientation, $F(1,\ 30) = 4.79$, $p < .04$, $\eta^2_p = .14$. The latter interaction indicates that the relation between configural similarity and component discriminability varies as a function of orientation. Therefore, we followed this interaction by separate analyses for upright and inverted faces.

Upright faces. The 2 (configural similarity) × 2 (discriminability) ANOVA, conducted on the RT data for upright faces, showed a main effect of discriminability, $F(1,\ 30) = 8.46$, $p < .007$, $\eta^2_p = .22$, and a significant interaction between discriminability and configural similarity, $F(1,\ 30) = 7.05$, $p < .02$, $\eta^2_p = .19$. As can be seen in Figure 4A, component discriminability had an effect on face discrimination performance in the SC, but not in the DC conditions. In the absence of configural variation (SC condition), faces differing in the most discriminable components were discriminated faster than faces differing in the least discriminable components, $F(1,\ 15) = 13.39$, $p < .003$, $\eta^2_p = .47$. In contrast, no effect of component discriminability was observed when configural variation was present (DC condition): The discrimination of faces differing in the least discriminable components was as fast as the discrimination of faces differing in the most discriminable components, $F < 1$.

These results could have indicated that in the presence of configural variation face discrimination relied solely on configural properties, suggesting relative dominance of configural properties in face processing. However, the significant interaction between discriminability and configural similarity also indicates that the presence of configural variation facilitated the discrimination of faces differing in the least discriminable components, but it had no effect whatsoever on the discrimination of faces differing in the most discriminable component. As can be seen in Figure 4A, discrimination of faces with the least discriminable components was about 100 ms faster in the DC than in the SC condition, $F(1, 30) = 3.21$, $p < .08$, $\eta_p^2 = .10$, whereas discrimination of faces differing in the most discriminable components was equally fast in the SC and DC conditions, $F < 1$.[2]

That is, discrimination of faces with dissimilar configural properties was faster than discrimination of faces with similar configural properties when the components were relatively difficult to discriminate, but not when they were relatively easy to discriminate. These results present some difficulty to the configural dominance hypothesis, according to which discrimination of faces with dissimilar configural properties should *always* be faster than discrimination of faces with similar configural properties, *regardless* of component discriminability.

A possible interpretation of these results is that when both component and configural properties are present, discrimination relies on the most discriminable aspect of faces—be it componential or configural. According to this "discriminability" account, the discrimination of faces with the relatively difficult to discriminate components improved when configural variation was present because discrimination was based on the configural properties, which presumably were more discriminable than the components, and configural variation had no effect on discrimination of faces with easy to discriminate components because this discrimination was based on the highly discriminable components.

As noted earlier, the discriminability of the spatial changes chosen for the DC condition was within the range of the discriminability of the individual components (in both RT and accuracy; see preliminary experiment, Footnote 2), suggesting that the configural properties and the components are of similar discriminability. However, the configural variation employed in the present experiment involved *both* intereyes distance and nose–mouth distance, and the componential variation involved *all* three components. Thus, the critical comparison relevant to examine the "discriminability" account is between the discrimination latency of faces differing (only) in all three components (SC condition) and the discrimination latency of faces differing (only) in the combined intercomponent spacing. Therefore, we conducted an additional, control experiment in which 16 participants discriminated between faces that were identical to each other except for

[2] One may argue that the lack of an effect of configural variation on discrimination of faces with the most discriminable components is due to a ceiling effect. This possibility, however, seems unlikely in light of the fact that accuracy in all conditions of this experiment was at ceiling.

their intereyes and nose–mouth distances—the exact same distances as those employed in the present experiment (Figure 5; two pairs of faces were used for the sake of generalization). The results showed a mean discrimination latency of 825 ms and mean ER of 6.75% (with no significant difference in discrimination performance between the two pairs, $p > .05$). These results suggest that the discriminability of the most discriminable components (mean = 719 ms) was greater than the configural discriminability ($p < .05$). Thus, the discrimination of faces with the most discriminable components in the DC condition could have been based on the components. Configural discriminability, however, was not greater than the discriminability of the least discriminable components (mean = 830 ms; $F < 1$). Therefore, the facilitation observed in the DC condition for the faces with the least discriminable components cannot be accounted for by greater discriminability of the configural properties relative to that of the components.

Actually, it appears that neither configural discriminability nor component discriminability predicted the discrimination of the faces that differed in both least discriminable components and configural properties: The

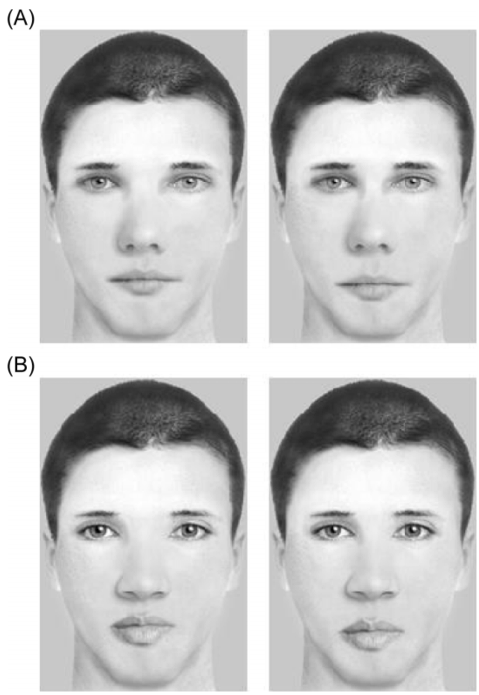

Figure 5. The stimuli used in the control experiment. The faces within each pair are identical to each other in components but vary in intereyes distance and in nose–mouth distance. The configural variation is the same in pairs A and B.

discrimination of these faces (mean = 724 ms) was faster than the discrimination of faces differing only in the least discriminable components (mean = 830 ms, SC condition) and faster than the discrimination of faces differing only in the configural properties (mean = 825 ms, control experiment, $p < .05$). These results are suggestive of interactive processing of component and configural properties. Were components and configural properties processed independently, then discrimination of the faces that differed in both components and configural properties should have been no faster than discrimination of faces differing in only components or in only configural properties.

Similar results suggestive of interactive processing were reported by Sergent's (1984): She found that differences in chin and internal spacing produced faster reaction time than differences in chin alone. Interactive processing of component and configural properties is also implicated in the results of Tanaka and Sengco (1997; see also, Pellicano, Rhodes, & Peters, 2006), which showed that changes in the spatial relation between the eyes (intereye distance) affected the recognition of the nose and mouth.

Thus, the present results provide some support for the discriminability account: Discrimination could rely on the components even in the presence of configural variation, granted that the components were more discriminable than the configural properties. Whether discrimination could rely on configural properties were they more discriminable than the components remains to be seen, but the present results do not rule out this possibility. In addition, discrimination of faces with component and configural properties of similar, relatively lower discriminability appeared to involve interactive processing. Taken together, these findings suggest that neither components nor configural properties necessarily dominate face processing.

Before turning to the analysis of inverted faces, further commenting on the results for the SC condition is called for. The results of Experiment 2 showed that the discrimination of faces that varied only in a single component, with no configural variation, was determined by the component discriminability. The results for the SC condition of the present experiment suggest that the same is true for faces that vary in multiple components (eyes, nose, and mouth). To further examine the contribution of the components to the face discrimination we tested the difference between the discrimination latency of the SC faces and discrimination latency of each of their components in isolation (Experiment 1—most and least discriminable pairs). A 2 (experiment) × 2 (discriminability) ANOVA with experiment (Experiment 3, Experiment 1) as a between-subjects factor and discriminability (most discriminable, least discriminable) as a within-subjects factor, was conducted for each component. All three analyses showed, as expected, a significant effect of discriminability, $F(1, 30) = 32.16$, $p < .0001$, $\eta_p^2 = .51$, $F(1, 30) = 26.74$, $p < .0001$, $\eta_p^2 = .47$, $F(1, 30) = 24.55$, $p < .0001$, $\eta_p^2 = .45$, for eyes, nose, and mouth, respectively, which did not interact with experiment, *F*s < 1, for eyes and nose, $F(1, 30) = 1.34$, $p > .25$, for mouth. No difference between experiments was observed for eyes and nose, *F*s < 1, but the discrimination latency of the SC faces was significantly slower than discrimination latency of isolated mouths, $F(1, 30) = 4.30$, $p < .05$, $\eta_p^2 = .12$.

Thus, the discrimination of faces differing in all three components was not faster than the discrimination of the easiest-to-discriminate component (the mouth); if anything, it was slower. These results suggest that facial components were processed independently in parallel. Apparently, the discrimination of faces that differed in all three components did not rely on the easiest component. This may suggest that face discrimination involved exhaustive processing of the facial components. Alternatively, it is possible that discrimination relied on a component other than the easiest one, such as the eyes, which was found to be relatively dominant in face recognition and identification (e.g., Barton, Radcliffe, Cherkasova, Edelman, & Intriligator, 2006; Davies, Ellis, & Shepherd, 1977: Haig, 1986; Schyns, Bonnar, & Gosselin, 2002; Sekuler et al., 2004).

Inverted faces. A 2 (configural similarity) × 2 (discriminability) ANOVA, conducted on discrimination RT for inverted faces, showed no significant effects of configural similarity, $F < 1$, and discriminability, $F(1, 30) = 1.39$, $p > .25$, and no interaction between configural similarity and discriminability, $F < 1$. As can be seen in Figure 4B, there was no difference in discrimination performance between the SC and DC conditions, and in both conditions discrimination of faces varying in the least discriminable components was as fast as discrimination of faces varying in the most discriminable components.

These results show, as expected, that the presence or absence of configural variation had no effect on the discrimination of inverted faces, suggesting that discrimination was based on the components. Interestingly, component discriminability also had no effect on discrimination performance. This null effect of component discriminability may be simply a consequence of the fact that the component discriminability was determined based on upright presentation of the components (see Experiment 1); component discriminability could be different for inverted components. Alternatively, it is possible that the discrimination of faces with the least discriminable components relied on the easiest component available (i.e., the mouth), and consequently the discrimination of faces with the least discriminable components turned out to be as fast as the discrimination of faces with the most discriminable components.

This latter conjecture was also supported by the results of a 2 (discriminability) × 2 (orientation) ANOVA, conducted for the SC condition. The analysis showed no effect of orientation, $F(1, 15) = 1.28$, $p > .28$, but a significant interaction between orientation and discriminability, $F(1, 15) = 7.47$, $p < .02$, $\eta_p^2 = .28$. As can be seen in Figure 4, discrimination of faces with the least discriminable components was faster for inverted than upright faces, whereas no difference between upright and inverted faces was observed for faces with the most discriminable components. Presumably, in discriminating faces differing in the least discriminable components, participants were extracting the easiest-to-discriminate component (i.e., mouth) when faces were inverted, but not when faces were upright—despite the fact that this was an efficient strategy. As noted earlier, whether discrimination of upright faces involved exhaustive processing or whether it relied on a component other than the easiest one, cannot be decided on the basis of our data.

Our finding that inversion did not hinder the discrimination of faces that differed only in components is compatible with previous results demonstrating that the perception of face parts is hardly disrupted by inversion (e.g., Freire et al., 2000; Leder & Bruce, 1998, 2000; Searcy & Bartlett, 1996). For example, Searcy and Bartlett (1996) showed that making faces grotesque by changing local features (such as blackening teeth) had a similar effect in both upright and inverted faces, Leder and Bruce (1998) showed that increased faces distinctiveness resulting from manipulating local features (such as darker eyebrows) was insensitive to inversion, and Leder and Bruce (2000) and Freire et al. (2000) demonstrated that inversion had no effect on recognition and discrimination ability when faces varied in parts.

GENERAL DISCUSSION

The main purpose of this study was to examine the relative dominance of component and configural properties in face processing. To this end we systematically manipulated the discriminability of facial components and examined whether the discriminability of the components predicted the discrimination of faces with similar versus dissimilar configural properties. The results demonstrated the important role of both component and configural properties in face discrimination, and revealed that the relation between these two types of properties is multifaceted.

When upright faces varied only in components, with spatial relations between components held constant across faces, their discrimination was predicted by the discriminability of the components. This was true both for faces that differed in a single component and for faces that differed in three components, indicating that in the absence of configural variation, upright faces are the sum of their components. Facial components do not interact with one another; rather, they are processed independently in parallel (see also, Macho & Leder, 1998; Sergent, 1984).

Contrary to the configural dominance hypothesis, faces with dissimilar configural properties were not necessarily faster to discriminate than faces with similar configural properties—the discriminability of the components mattered. Thus, the discrimination of faces that varied in configural properties (that were not very easy to discriminate in and of themselves) was as fast as the discrimination of faces with similar configural properties when the components were highly discriminable, suggesting that discrimination was based on the components. The presence of configural variation, however, facilitated the discrimination of faces with the more difficult-to-discriminate components, above and beyond what would be predicted by the componential or configural discriminability. These results suggest interactive processing of component and configural properties when the two types of properties are of similar discriminability (none of which is very high). Some previous findings are also suggestive of such interactive processing in face discrimination and recognition (Ingvalson & Wenger, 2005; Sergent, 1984; Tanaka & Sengco, 1997). Further support is provided by a recent study that examined the separability/integrality of componential and configural information using Garner's (1974) speeded classification paradigm (Amishav & Kimchi, in press). The results of this study showed that participants could not selectively attend to the components while ignoring irrelevant variation in configural properties, and vice versa, suggesting that components and configural properties interact during face processing.

In contrast to upright faces, the discrimination of inverted faces was not influenced by presence or absence of configural variation. This result converges with previous findings (e.g., Freire et al., 2000; Leder & Bruce, 1998, 2000; Searcy & Bartlett, 1996) indicating that processing of inverted faces is insensitive to configural information. Our results further suggest the possibility that in discriminating inverted faces with relatively difficult-to-discriminate components, the easiest component was extracted in performing the task. Apparently, this strategy, despite being efficient, was not used with upright faces, either because discrimination of upright faces differing only in components involved exhaustive processing, or alternatively, that discrimination relied on a component other than the easiest one (e.g., the eyes).

The results of the present study are not consistent with the holistic view of face perception, at least in its extreme version, which assumes that faces are represented and processed as undifferentiated gestalts, so that faces are not decomposed into parts (Farah et al., 1998; Tanaka & Farah, 1993). Our results challenge this assumption, demonstrating that facial components are explicitly represented in upright faces and do not interact with one another: Not only the discriminability of the components determined the discrimination of faces that varied only in components, but apparently, even when faces varied in both components and configural properties, discrimination was based on the components when the components were easy to discriminate.

Our results are also inconsistent with the configural view, in particular the dual-mode hypothesis, which assumes that component and configural properties are processed independently and configural properties dominate the processing of upright faces (e.g., Bartlett, Searcy, & Abdi, 2003; Searcy & Bartlett, 1996). Although our results are compatible with the assumption that component and configural properties are distinct sources of information (see also, e.g., Rotshtein et al., 2007; Schwaninger et al., 2003; Searcy & Bartlett, 1996; Yovel & Duchaine, 2006), they clearly demonstrate that configural properties do not necessarily dominate components in discrimination of upright faces, and that component and configural properties can be processed in an interactive manner. A recent test of the dual-mode hypothesis also failed to support the assumption that component and configural properties are processed independently (Ingvalson & Wenger, 2005).

The present results shed a new light on the interplay between component and configural properties and on the nature of "holistic" face processing. In view of our results, we propose that both component and configural properties contribute to the processing of upright faces and no property necessarily dominates the other. Upright faces can be discriminated by components, by configural properties, or by interactive processing of component and configural properties, depending on the information available and the discriminability of the properties. The processing of inverted faces, on the other hand, is dominated by components. We further propose that the essence of "holistic" face processing is the interactive processing of component and configural properties.

Several investigators expressed the view that some sort of interactive processing is the gist of "holistic" face processing (e.g., Mckone, 2004, 2008; Moscovitch, Winocur, & Behrmann, 1997; Yovel & Kanwisher, 2004). Thus, it has been suggested that holistic processing refers to mandatory perceptual integration across the entire face region, including components and second-order spatial relations (Mckone, 2008), or similarly, to mandatory interactive processing of facial information, including interactive processing of facial components (Yovel & Kanwisher, 2004). Our results do not support such an all-inclusive interactive processing; we clearly demonstrated that facial components do not interact, but are processed independently. Our results, however, do suggest that component and configural properties can be processed in an interactive manner. Thus, our notion of holistic processing refers to specific interactive processing—that of component and configural properties.

Before concluding, it should be noted that the role of components may have been overestimated in our study, for two reasons. First, we used a discrimination task, and it is possible that configural properties are more important and may even dominate components in face recognition. Several researchers proposed that recognition of a previously seen faces may involve separate processes or strategies than perceiving aspects of currently present faces (e.g., Bruce & Young, 1986; Rotshtein et al., 2007; Tanaka & Sengco, 1997). For example, Rotshtein et al. (2007) provided evidence suggesting that facial components dominate face discrimination, whereas spatial relations between components (spacing) are correlated with recognition skills, thus indicating their importance for face recognition (but see Konar et al., 2010). Second, it has been argued that the use of only two faces in a block of trials may encourage a componential processing strategy because it is easier to focus on differing components when there are only two alternatives, particularly when the two faces are repeated (e.g., Schwarzer & Massaro, 2001; Roisson, 2008). Notwithstanding these arguments, our method nevertheless enabled us to uncover both the role of components discriminability, and the possibility of interactive processing of component and configural properties. Therefore, our results appear to be indicative of the relationships between processing of component and configural properties.

Our finding that interactive processing of component and configural properties surfaced when faces varied in component and configural properties of similar (and not very high) discriminability, suggests that such interactive processing may very well be the dominant form of face processing in everyday life. Apparently, faces can be discriminated or recognized by components or by configural properties if one or the other is the only information available or is highly distinctive and discriminable. This may be particularly viable when the set of alternative faces is rather limited—as was the case in our experiments—making it easier to identify the distinctive property, but it is also likely in some real life situations, in which a component or a configural property is particularly distinguishing. In everyday life, however, we usually encounter an enormous number of faces that vary in both component and configural properties; some of the differences between faces can be quite subtle. Interactive processing of configural and component properties can thus enable us to distinguish between faces and to uniquely identify or recognize an individual face.

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